

Glass and Mechanical Strength

Technical Bulletin



PILKINGTON

Contents

Introduction

Page 3

Regulations and Standards

Page 4

Design and Applications

Page 5–16



Introduction

The unique quality of transparency is what normally determines the use of glass for a particular building application. However, there are many applications where the material's mechanical strength is also an important factor to be considered. On the one hand it may be the (relatively) simple matter of satisfying building and occupant safety requirements and regulations for situations such as barriers, stairs etc. On the other hand, it may be the key to achieving a stunning architectural design – a complete glass wall, a glass staircase or floor – or specialist feature such as the glass side of an aquarium where a killer whale is housed.

The choice of the right glass is critical in such applications, and whilst most will require detailed design calculations, this publication provides guidance to the use of glass in situations where mechanical strength is an important factor.

Thick Pilkington **Optifloat**, Pilkington Laminated Safety Glass, and Pilkington Toughened Safety Glass all possess qualities that make them suitable for applications where mechanical strength is of paramount importance. It is also possible to use the Pilkington **Pyroshield** range of wired, fire resistant glasses in applications such as roof glazing where the inherent mechanical rather than fire resistant qualities of the material are desirable.

Regulations and Standards

Building Regulations

England and Wales

The Building Regulations 1991 Stairs, Ramps and Guards Part K.

Approved Document K Stairs, Ramps and Guards 1992 Edition gives general guidance on the interpretation of the requirements.

Scotland

The Building Standards (Scotland) Regulations 1990 Part S Stairs, Ramps and Protective Barriers.

The 1990 Technical Standards document provides guidance on the interpretation of the requirements.

Northern Ireland

The Building Regulations Northern Ireland 1994, Part H Stairs, Ramps and Guarding.

Technical Booklet H Stairs Ramps and Guarding, 1994 provides guidance on the interpretation of the requirements.

British Standards

BS 6180: 1999

Code of practice for barriers in and about buildings.

BS 6206: 1981

Specification for impact performance requirement for flat safety glass and safety plastics for use in buildings.

BS 6262: 1982

Code of practice for glazing for buildings.

BS 6399:

Loading for Buildings – All Parts.

In certain cases the various Regulations and Standards define the design loadings that need to be taken into account (e.g Horizontal Uniformly Distributed Load, Concentrated Load etc.), and when applicable, these have been used in the generation of the tables.

Designs outside these guidelines must be referred to Pilkington for consideration and advice.

Design and Applications

The following sections provide general guidance to the required glass thickness, maximum areas, spans etc. for Pilkington Glasses used in the following selection of popular applications where mechanical strength is a major consideration:

- Free Standing Glass Protective Barriers
- Pilkington Toughened Safety Glass Infill Panels for Barriers
- Pilkington Laminated Safety Glass Infill Panels for Barriers
- Glass Mullions – full height
- Glass Floors
- Overhead Glazing



Houndshell Shopping Centre, Blackpool

CONTENTS

INTRODUCTION

REGULATIONS

DESIGN

PLANAR

PRODUCT
OVERVIEW

WIND
LOADING

CALCULATION
PROGRAMS



Barriers

The term ‘barrier’ is used rather than ‘balustrade’ as not all balustrades have balusters, therefore ‘barrier’ is a more precise terminology.

Pilkington Toughened Safety Glass for Free-Standing Glass Protective Barriers

Table 3 gives the usual thicknesses of Pilkington Toughened Safety Glass required for free-standing glass protective barriers. The thicknesses may alter if the top edge of the clamping detail is positioned a significant distance above or below the finished floor level.

Table 3 – Glass thickness for free-standing protective barriers – Pilkington Toughened Safety Glass

Design Level Horizontal UDL (Line Load) (kN/m)	Pilkington Toughened Safety Glass Thickness (mm)
0.36	12
0.74	15
1.5	19
3.0	25

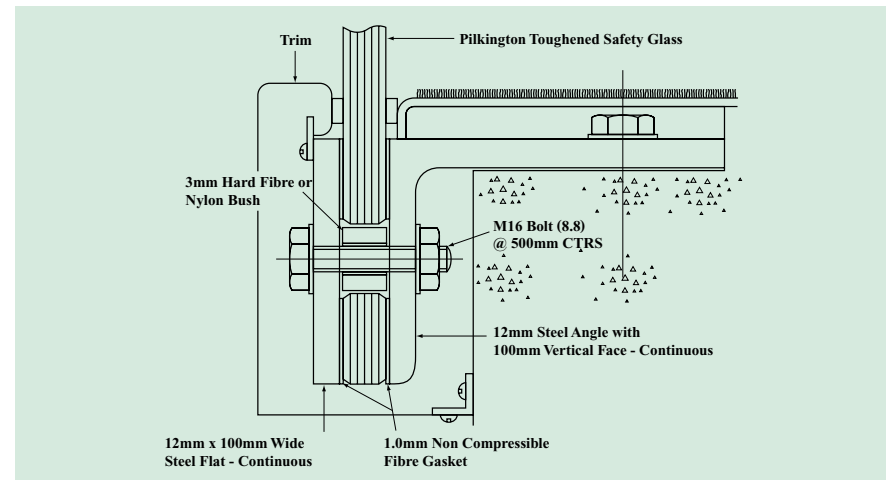


Figure 1. Typical Clamping System for Pilkington Toughened Safety Glass Free-standing Protective Barrier

Pilkington Toughened Safety Glass Infill Panels for Barriers

Table 4 gives the maximum spans for Pilkington Toughened Safety Glass infill panels attached at the ends by bolted connections to the balusters. Although the spans given in the table are the technical design limitations of the glass, in accordance with the principles of BS6180, it is recommended that balustrade infill panels should be limited to a length of around 1500 to 2000mm, since the glass may appear to be rather flexible to the casual observer if the spans are longer than this.

Table 4 – Maximum spans for bolted Pilkington Toughened Safety Glass Infill panels for barriers (Applicable only for pane widths greater than 700mm)

Infill Loading From BS 6180		Span Limit for Bolted Pilkington Toughened Glass (mm)			
UDL (kN/m ²)	Point Load (kN)	6mm*	8mm*	10mm	12mm
0.5	0.25	1400	1750	2100	2400
1.0	0.5	900	1450	1750	2050
1.5	1.5	N/A	N/A	1200	1600

*6 and 8mm Pilkington Toughened Safety Glass will not be suitable if the free path perpendicular to the barrier is larger than 1.5m, since it will not give containment (i.e. remain intact) at Class A of BS 6206: 1981.

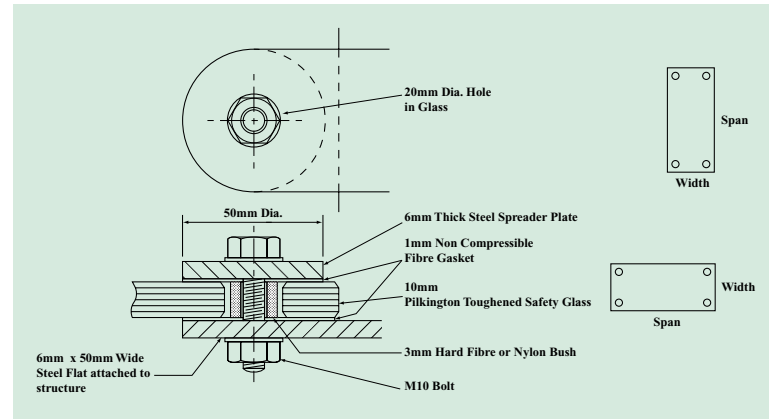


Figure 2. Typical bolt fixing arrangement for Pilkington Toughened Safety Glass Infill Panel for a protective barrier

Pilkington Laminated Safety Glass Infill Panels for Barriers

Table 5 gives the typical minimum thicknesses of Pilkington Laminated Safety Glass appropriate for infill panels. BS 6180 states that laminated glass is suitable for barriers where the glass is used fully framed. The table has been based on maximum glass area of 3.4m². The thicknesses may need to be increased depending on the size of the panes and on other possible load requirements.



Pilkington Toughened Safety Glass – Infill Panels

**Table 5 – Thickness of glass infill panels for barriers
– Pilkington Laminated Safety Glass (The frame section should
give a minimum edge cover of 15mm to the glass)**

Infill Loading from BS 6180		Pilkington Laminated Safety Glass Thickness (mm)
Concentrated Load (kN)	UDL (kN/m ²)	
0.25	0.5	6.8
0.5	1.0	8.8
1.5	1.5	12.8

Glass Mullions (or Fins)

To provide a high degree of visual access into buildings, Pilkington have over a period of years developed and engineered various types of glass mullion systems. These systems exploit the full potential of glass as a structural material – providing support for the main facades whilst at the same time presenting the minimum in visual barriers.

Typical applications are: entrance areas and atria in offices and public buildings and in sports stadia.

For the system considered below the top and bottom edges of mullions must be suitably supported and restrained within fin boxes and bonded to the main plates with high strength silicone sealant.

The mullion thicknesses have been based on a 5mm wide joint between adjacent main plates.

Mullion width dimensions have been based on the use of thick annealed Pilkington **Optifloat**. However, the use of Pilkington Toughened Safety Glass would provide the ability to notch the top and bottom edges of the mullion with the potential for a simpler fin box installation.

The limited aspect ratio capability of toughened glass will invariably result in toughened glass mullions needing to be wider than the dimensions specified.

Table 6 – Thickness and width of full height glass mullions

Height of Mullion (mm)	Design Wind Load (N/m ²)			
	1000	1250	1500	1750
Mullion Thickness/Width (mm/mm)				
Up to 2000	19/120	19/130	25/120	25/130
Up to 2500	19/160	25/160	25/170	
Up to 3000	25/180	25/200		
Up to 3500	25/230			
Up to 4000	25/280			

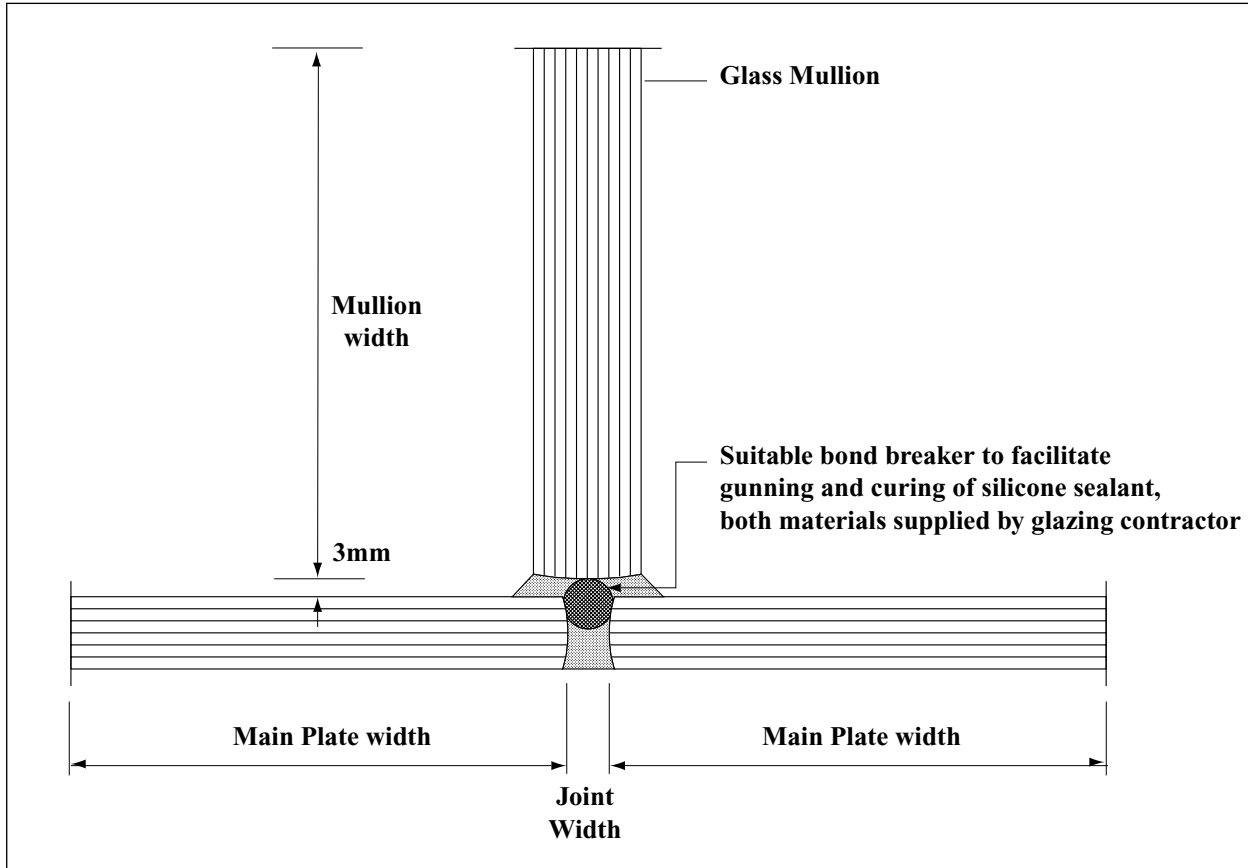


Figure 3. Glass mullion to main plates joint detail

Glass Floors and Stairtreads

The following should be treated as general guidance only.

The uniformly distributed and concentrated design loads for floors and stairtreads should be determined from BS 6399: Part 1.

The preferred general glass specification is Pilkington Laminated Safety Glass incorporating thick annealed Pilkington **Optifloat** suitably supported along all four edges.

Approximately 1m^2 is usually considered to be a practical maximum area for each pane of glass due to handling considerations.

Table 7 is based on a 1m^2 floor pane and a 300 x 1500mm stairtread pane, and relates the design loading to the glass ply thicknesses for each Pilkington Laminated Safety Glass pane.

The glasses should be installed with the thicker glass ply uppermost.

The glasses should be installed with the thicker glass ply uppermost.

Consideration must be given to the surface finish of the glass

Table 7 – Glass ply thicknesses for floors and stairtreads using Pilkington Laminated Safety Glass (Based on floor pane 1m^2 in area, and stairtread measuring 300 x 1500mm)

Intensity of Distributed Load (kN/m ²)	Concentrated Load (kN)	Pilkington Safety Laminated Glass Configuration (mm + mm)	Typical Usage
1.5	1.4	19 + 10	Domestic
5.0	3.6	25 + 15	Dance Floor
4.0	4.5	25 + 25	Corridors
4.0	4.0	25 + 10	Stairtread

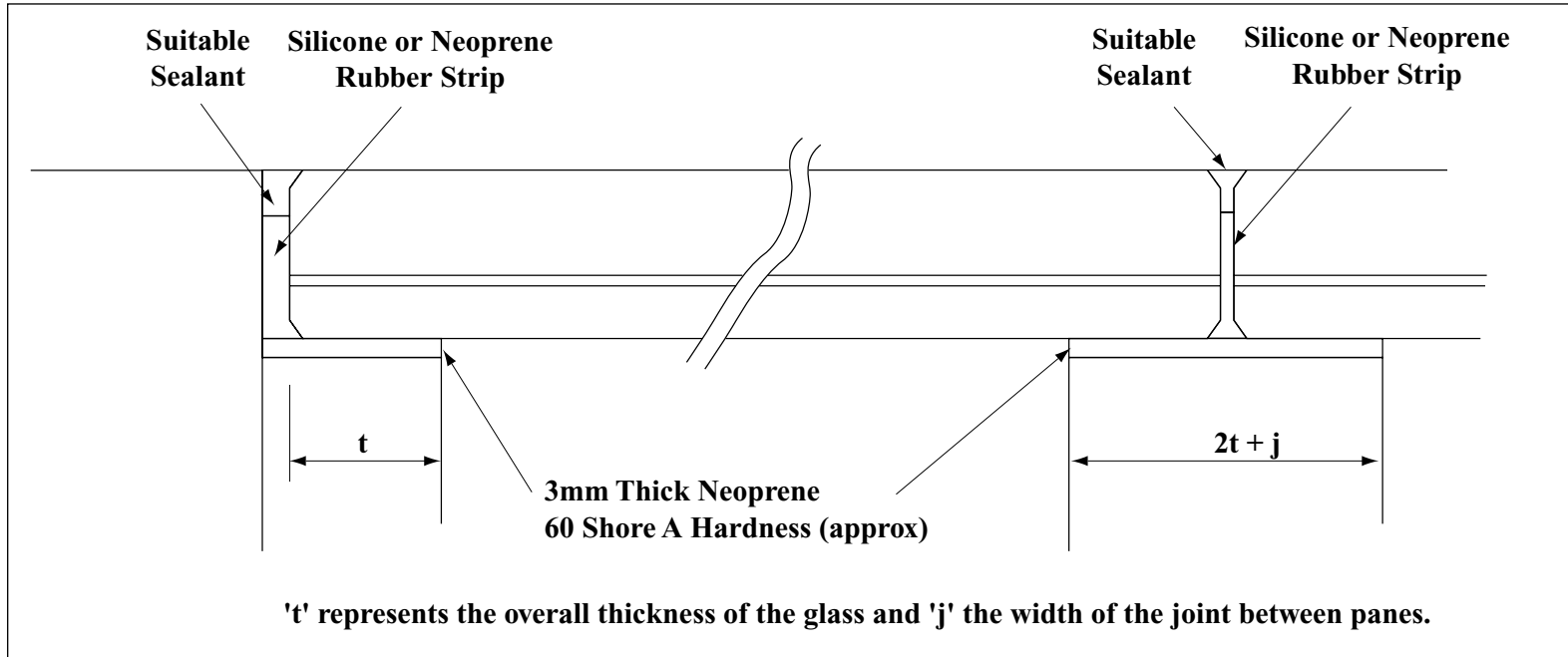


Figure 4. Illustration showing the glazing principles to be adopted when installing four edges supported internal glass floor panels (for pedestrian traffic only)

Overhead Glazing at a height less than 13m above floor level

(two opposite edges supported)

Table 8 is based on the following maximum, separately applied, loads being applied to the glass:

Snow 750N/m^2

Wind 1200N/m^2

Further information on overhead glazing is given in the Pilkington Technical Bulletin 'Glass and Safety'.

Table 8 – Maximum distance between supports; two edge supported glass (based on maximum, separately applied loads of snow: 750N/m²; Wind: 1200N/m²)

Glass Type and Nominal Thickness*	Maximum Distance Between Supports (mm)
Single Glazing	
4mm Pilkington Toughened Safety Glass	670
6mm Pilkington Toughened Safety Glass	1000
6mm Pilkington Laminated Safety Glass	700
8mm Pilkington Laminated Safety Glass	840
10mm Pilkington Laminated Safety Glass	910
Pilkington Pyroshield **	680
Pilkington Insulight	
4mm Pilkington Toughened Safety Glass + 4mm Pilkington Toughened Safety Glass	820
6mm Pilkington Toughened Safety Glass + 6mm Pilkington Toughened Safety Glass	1230
4mm Pilkington Toughened Safety Glass + 6mm Pilkington Laminated Safety Glass	760
6mm Pilkington Toughened Safety Glass + 6mm Pilkington Laminated Safety Glass	950

* Nominal thickness of Pilkington Laminated Safety Glass is the sum of the nominal thicknesses of the glass plies, ignoring the interlayer thickness.

** The full range of Pilkington **Pyroshield** can be used in overhead glazing.
 A thermal safety check should be carried out on all non-toughened glasses whenever there is the potential for the glass to be thermally overstressed. The glass should never directly carry a maintenance load.

CONTENTS

INTRODUCTION

REGULATIONS

DESIGN

PLANAR

PRODUCT
OVERVIEW

WIND
LOADING

CALCULATION
PROGRAMS



Liverpool St. Train Station

This publication gives a general description of the product and materials. It is the responsibility of the user of this document to ensure that their use is appropriate for any particular application and that such application complies with all relevant local and and national legislation, standards, codes of practice and other requirements.

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